COREBA

(Cognition Oriented Emergent Behavior Architecture)

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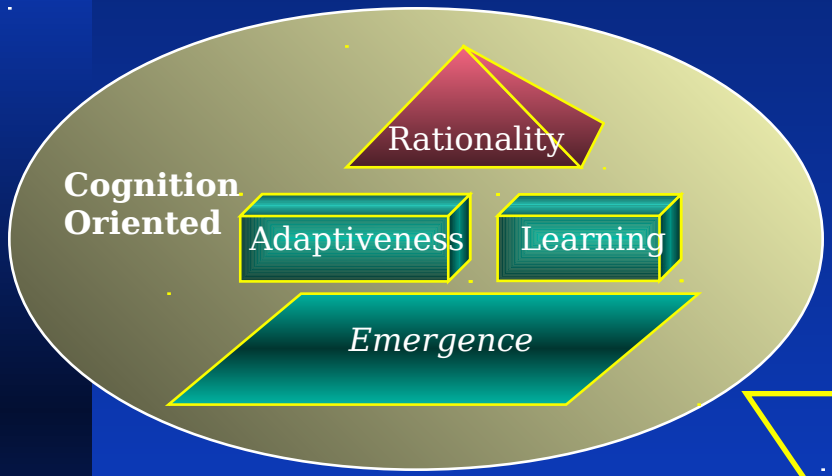
Contents

- Introduction to COREBA
- JFACC EA demo
  - Evaluation Agent
- Coyote98 (AFRL-Mesa, Az) SAWD demo
  - Synthetic AWACS Weapons Director
- COREBA Behaviors
- Summary

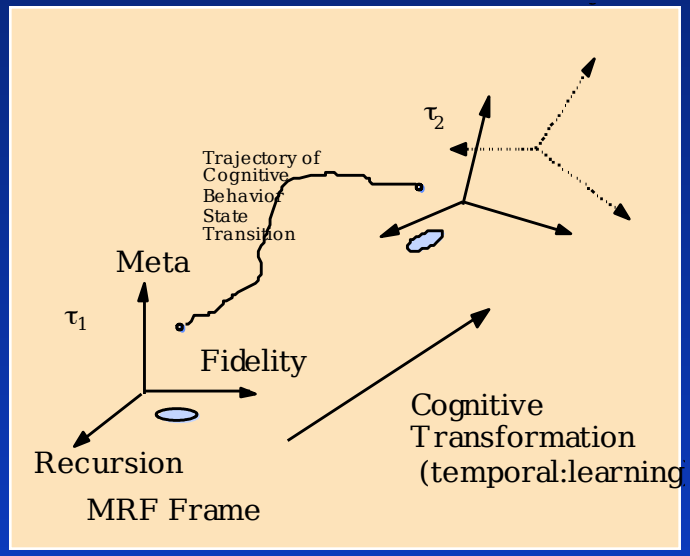
What is COREBA?

- Cognition ORiented Emergent Behavior Architecture
- COREBA is the ASC's answer to the current M&S behavior problem -- *high development cost and poor higher level behavior performance*
- COREBA
  - Enables construction of human like behaviors (rational, adaptive, learning)
  - Facilitates construction of behaviors with its unique full life cycle support ranging from knowledge acquisition, behavior representation, behavior development, behavior setup, behavior execution, to behavior validation.
  - Is an open architecture to reuse existing investments.

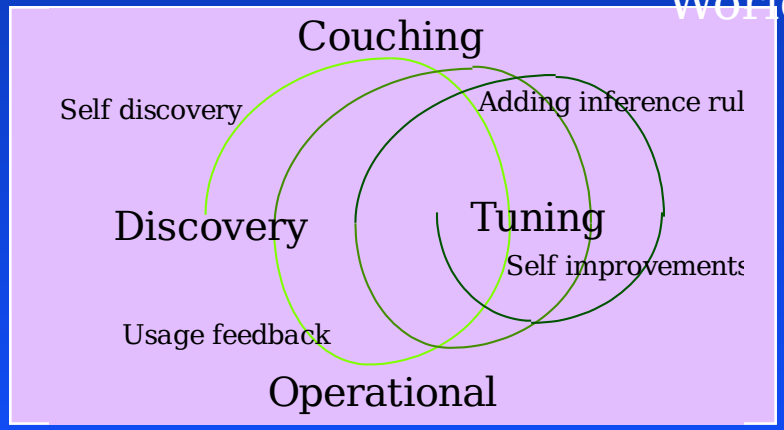
COREBA's Trio



COREBA Functional Components

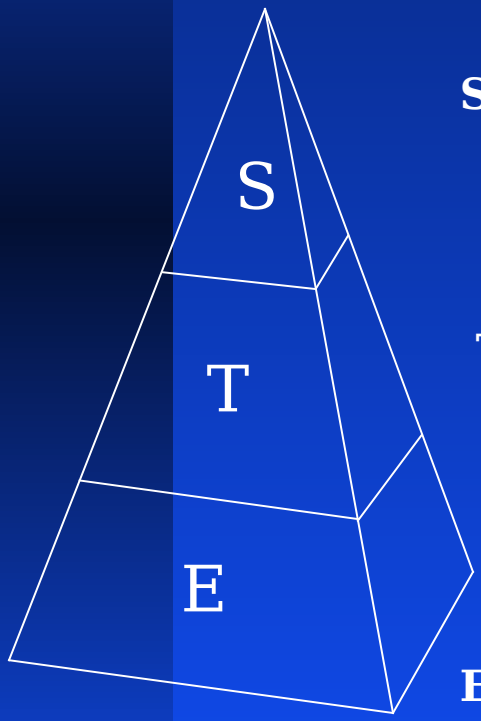


COREBA Cognitive World



COREBA Modes of Operation

How Does COREBA Work



COREBA Agent

Level

Strategic

Rules
Human friendly
- Policy, Doctrine, etc
- Rules of thumb

Rational Reasoning

Tactical

Emergent Patterns
Human friendly
- Behavior
- Decisions
- Information Fusion
- Collaboration

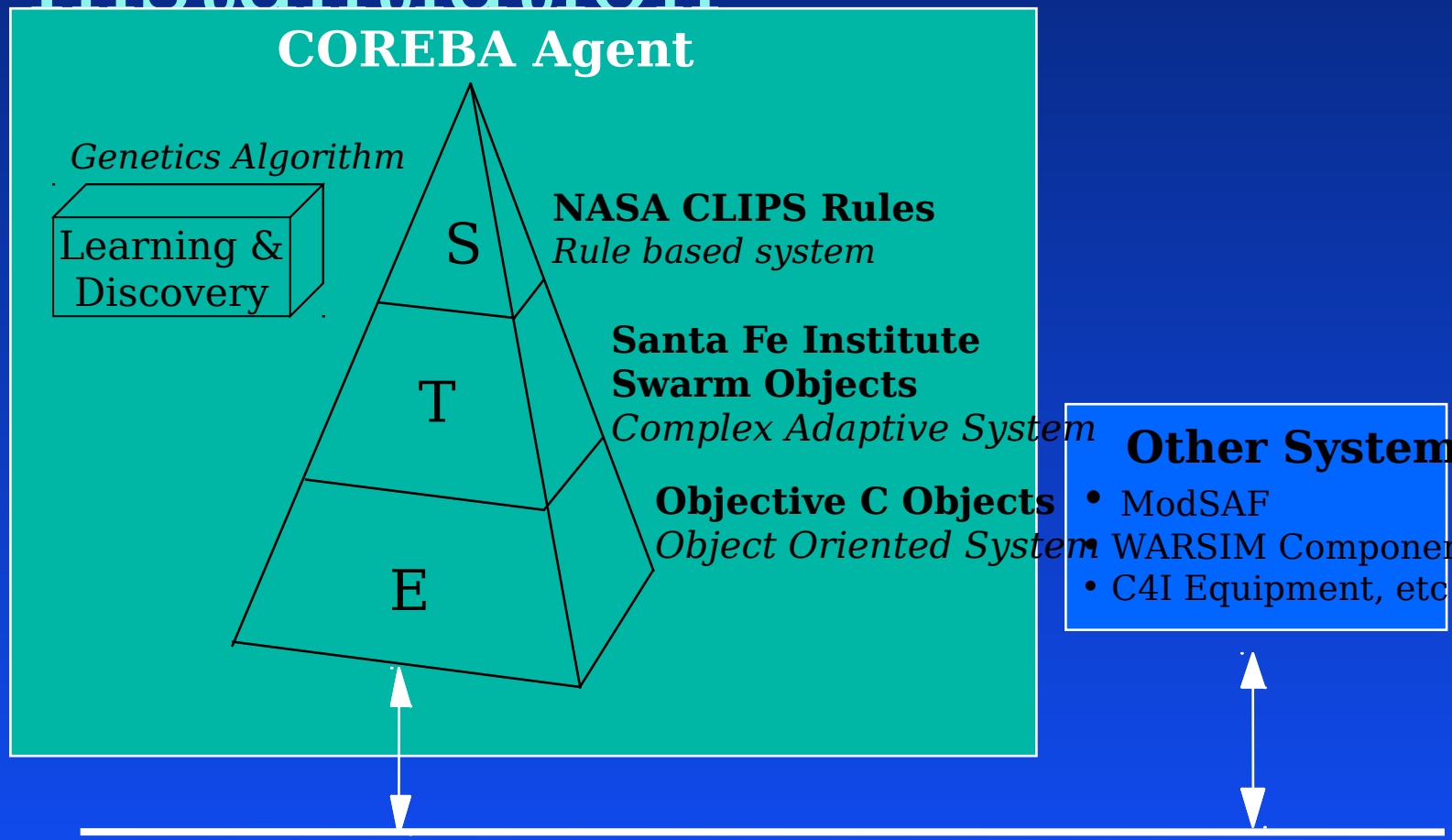
Common Sense

Execution

Sensors and Actuators
Interfacing to
- Physical world
- Other systems
- Other COREBA agents

Interactions & Reflexes

COREBA Agent Instantiation



Therefore, COREBA

- Is a Multiple Paradigm Behavior Architecture
  - Synergistic technology integration under a unique behavior architecture
- Is an open behavior implementation architecture
  - Maximize reuse of existing software investments
- Facilitates construction of *cheaper, better* and *faster* M&S behaviors.

JFACC's COREBA is a breakthrough cognitive technology for continuous adaptive planning, assessment, and execution.

Evaluator Agent Demo for JFACC

Funded by DARPA JFACC

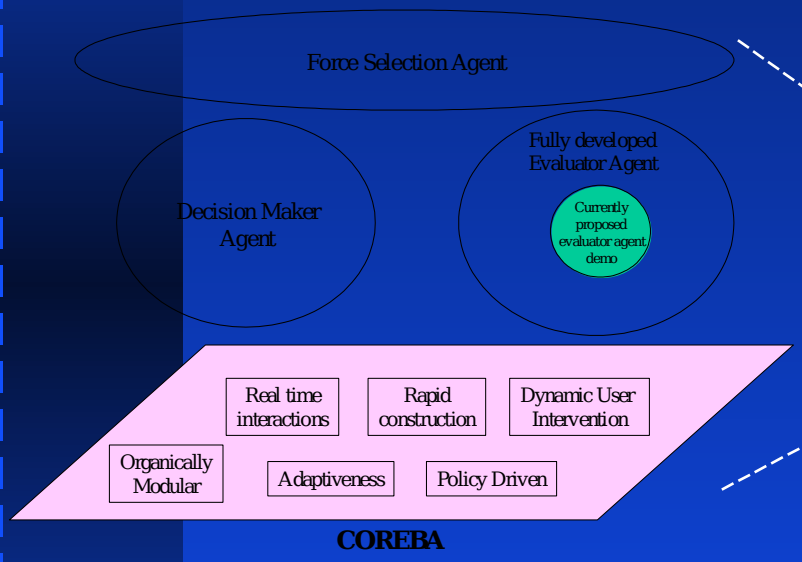
JFACC's COREBA is a breakthrough cognitive technology for continuous adaptive planning, assessment, and execution.

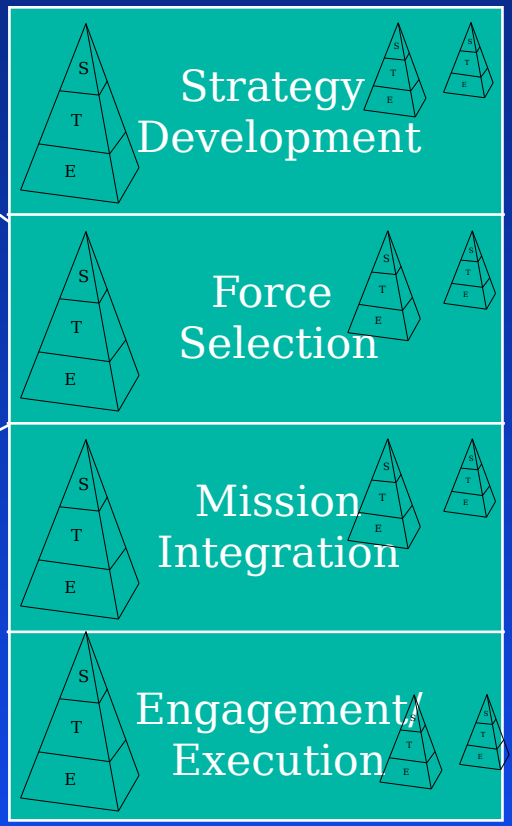
Contents

- Characterizing Force Selection Agent
- Describe demo evaluator agent in the context of Force Selection Agent
- Evaluator Agent Demo
  - Excursion scenarios
  - Interactive demo

COREBA Application in JFACC

First COREBA is applied for Force Selection Component.





Applied to all of the JFACC components

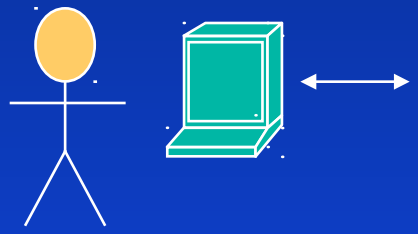
JFACC's COREBA is a breakthrough cognitive technology for continuous adaptive planning, assessment, and execution.

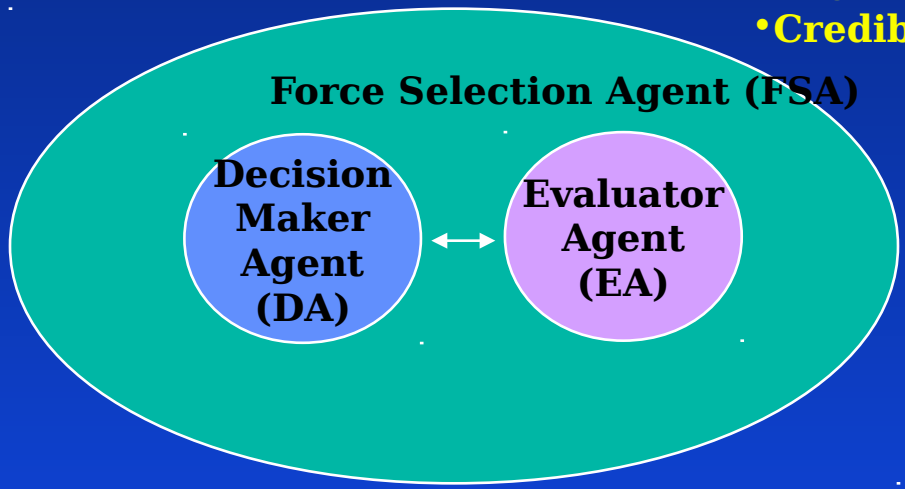
Coherently collaborating with CPR.

Characterizing Force Selection Agent

Human performs Apportionment Decision with FSA

- Force Mix (% AA)
- Force Disposition
- Force Employment
- Doctrine/Policies





- **Scalable**
- **Modifiable**
- **Easily constructive**
- **Organically modula**
- **Credible results**

FSA works with DA and EA while injecting following factors

- Personal Experiences
- Historical trends
- Common doctrines

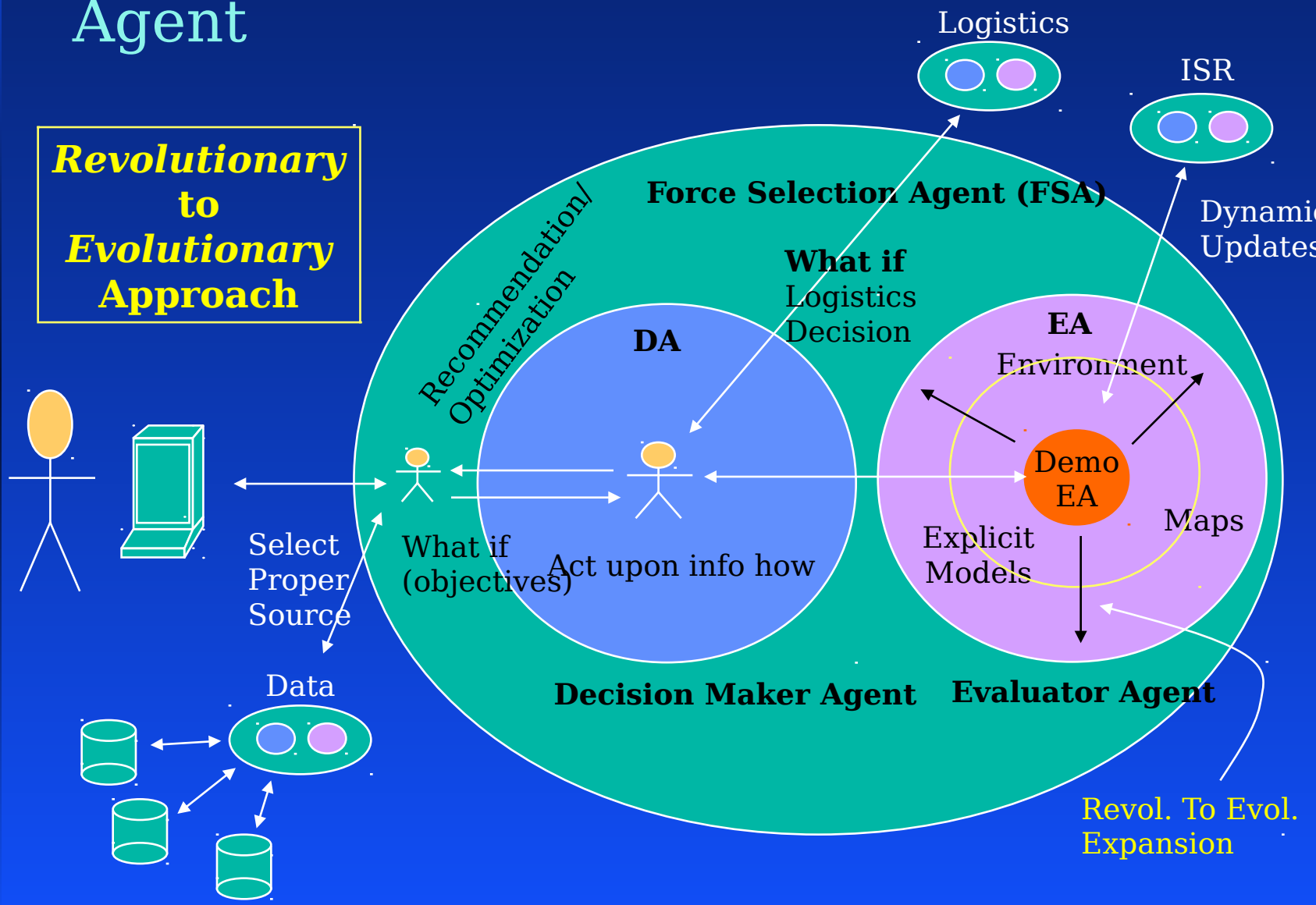
DA optimizes with EA

- Disposition
- Force mix (%AA - AG)
- Rules (BCA)
- Pre/Transition to Hostility

EA evaluates for D and generates

- Recommendations
- Evaluation matrix

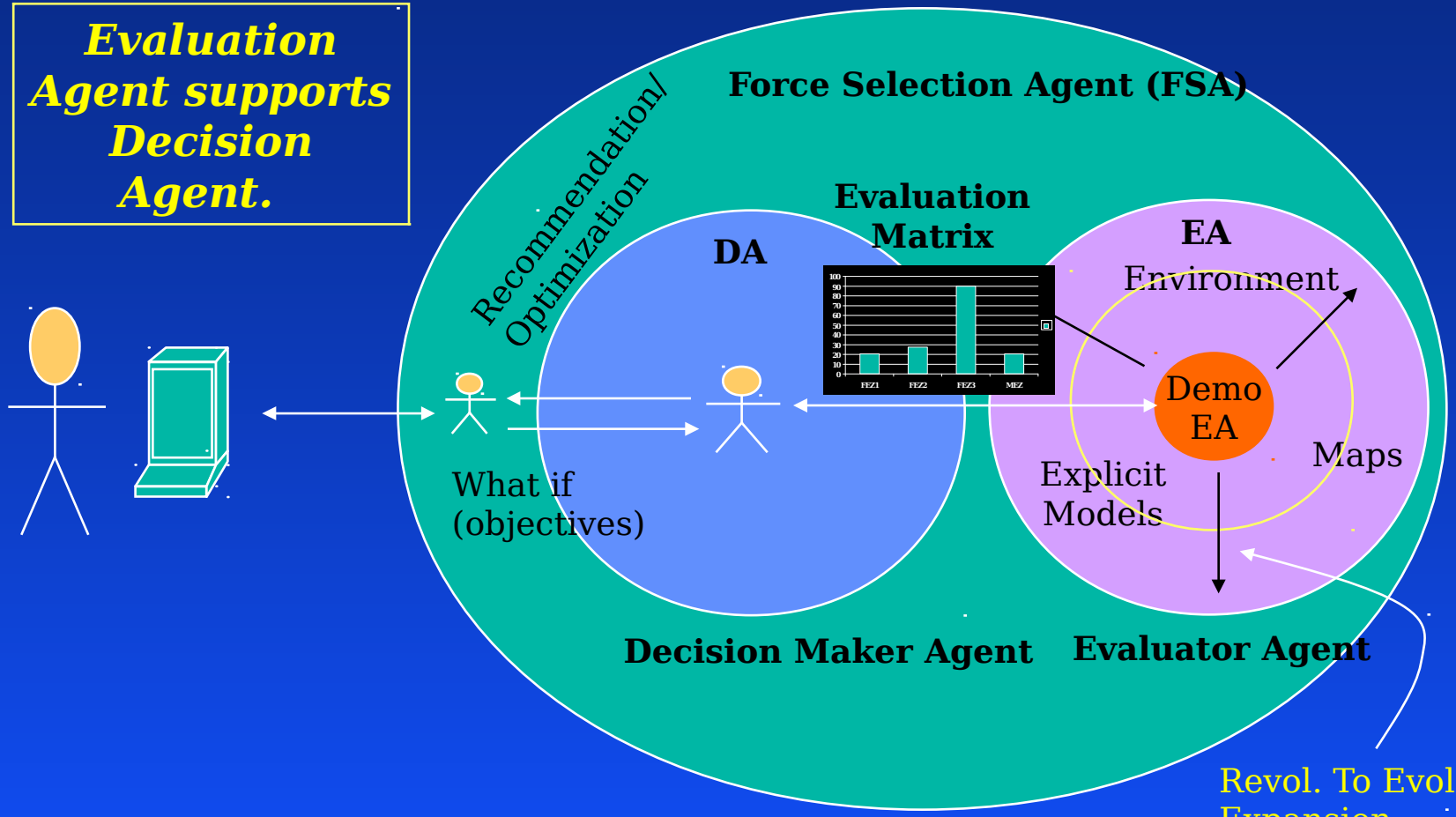
Evaluator Demo Agent to Force Selection Agent



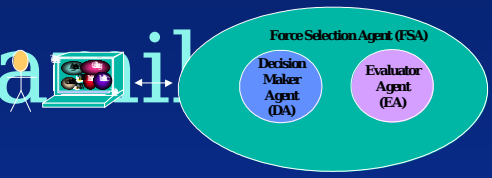
***Revolutionary* to *Evolutionary* Approach**

Evaluation Matrix from EA to DA

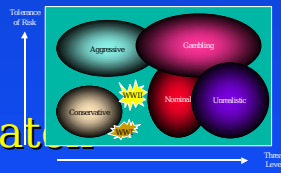
Evaluation Agent supports Decision Agent.



Force Selection Agent Family

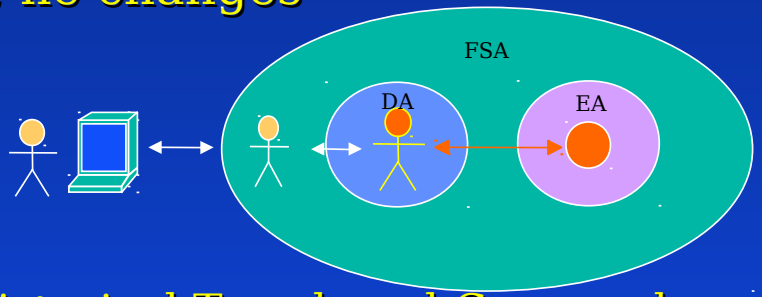


- Evaluator Agent (EA)
  - Quickly evaluate scenarios (much faster than real time)
  - Real time ISR interactions
- Decision Maker Agent (DA)
  - Differentiates and guides decision factors, such as force disposition, force mix, force employment based on policies and doctrines under a given logistics conditions
  - Executes different decision parameters for optimizing trading space
- Force Selection Agent (FSA)
  - Guides force apportionment decision making
    - Based on policies, political objectives, etc
  - Interacts with multiple Data Sources, Dynamically choose proper data sources, Learning (personal, historical, commonly accepted doctrines)
- Graphic User Interface
  - GUI that has cognitive paradigm mat

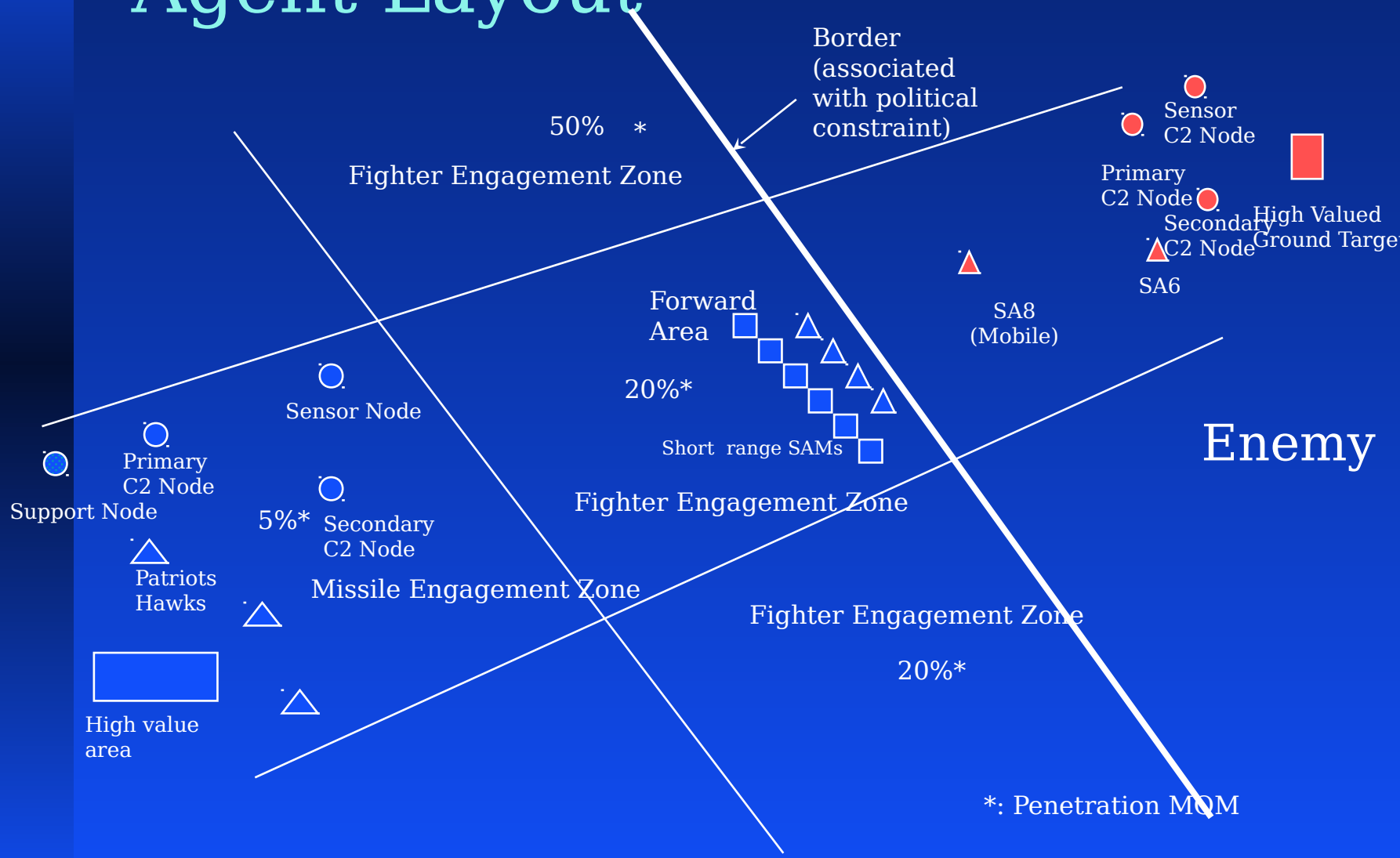


JFACC Evaluator Agent Demo

- Provide operational concepts with the Evaluation Demo Agent
- Human acts like a decision making agent
  - Thus, using his intelligence, he changes
    - Force disposition
    - Force mix
    - Force Employment
    - Doctrine/policies
    - Based on Personal traits, Historical Trend, and Commonly accepted doctrines
  - To generate recommendation with evaluation matrix
- Thus, EA supports force apportionment and decision



Example JFACC Evaluator Agent Layout



JFACC Evaluator Agent Demo

- Base Case: Defensive Counter Air (DCA)
- Disposition of assets
  - Move SAMs forward and optimize barrier defense (vs. point defense)
- Force mix changes
  - Change role of one wing of F-15E to A/A
- Change ROE/Political boundary
  - Border Crossing Authority (BCA)

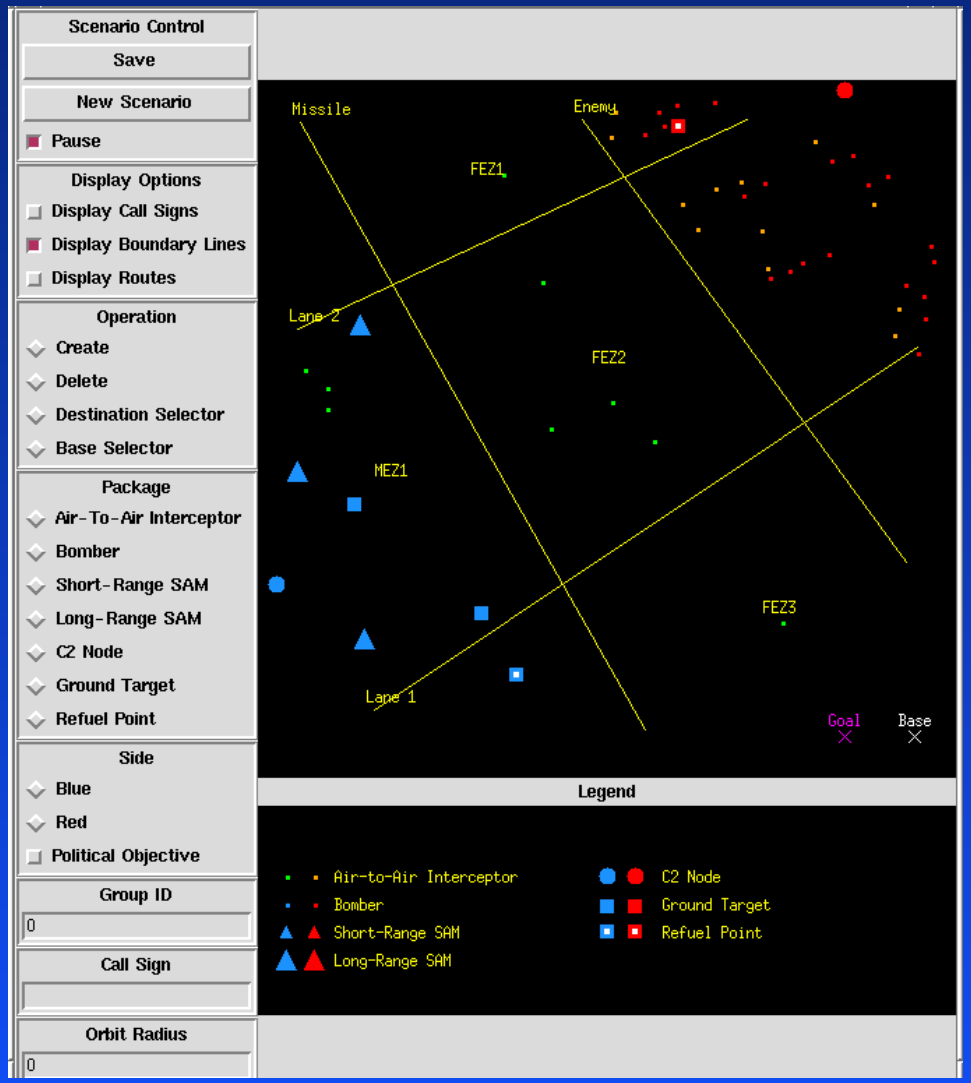
JFACC Evaluator Agent Demo (cont.)

- Faster than real time evaluation (50:1)
  - Performing projection based on anticipated behaviors of both BLUEFOR and OPFOR.
  - Blue and OP doctrines are used to generate behaviors.
- Allows simulated real time injections of ISR data
  - Continuous planning and execution paradigm

Expected Demo Results

Decision Agent's interactions	Expected Result
Initial Case	Both high valued ground targets are destroyed
Force Disposition (Forward SAMs)	One of the high valued ground targets is saved
Force Mix (Re-role to A/A)	Both high valued ground targets are saved
Political Objective (BCA)	Some of red planes are saved while successfully defending both high valued ground targets

JFACC EA Demo Screen



Results/Proof from FY98 Demo

- **Continuous execution and modification allowed (rules and participants)**
  - Modular and extensible (Ex: scenario construction with drag and drop)
  - Adaptive (Ex: reconfigurable model element with changing mission)
  - Dynamic interventions (Ex: adjust location and number of entities (while running))
  - Attribute changes (Ex: adjusting constraints, objectives and conditions)
- **Quick scenario creation and evaluation (much faster than real time, 50:1)**
- **Captures policies and doctrine**
- **Operates with incomplete data and rules**
- **Organically modular behavior emergence**
- **Credible results (non-random)**
- **Mirrors military decision making architecture (scaleable)**
- **Captures many more variables than a human is capable of considering**
- **Simulated real time ISR interactions**
- **FY98 Demo EA capability produced in 3.5 staff month effort**
  - **Approximately half of budget was development.**

Coyote98
Synthetic AWACS Weapons Director (SAWD)

Funded by HQ USAF/XOCA

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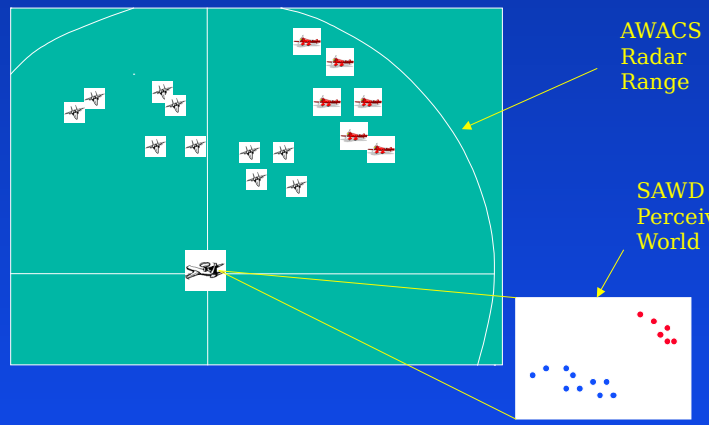
SAWD Demo

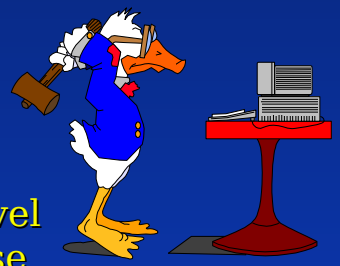
- Objective
  - Training Support Man Power Reduction
- Operational Approach
  - SAWD automates AWACS weapons director operations.
    - Is fully adaptive to new situation
      - Does not require scripted scenario
      - Facilitates real time C4ISR injection
  - SAWD controls/collaborates AirSF agents
    - Anticipates the battle scenes (both BLUE and OPFOR)
    - Guides the AirSF agents
    - Monitors the engagement progress.

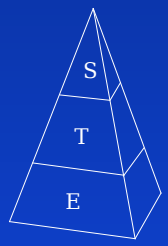


Synthetic AWACS Weapons Director

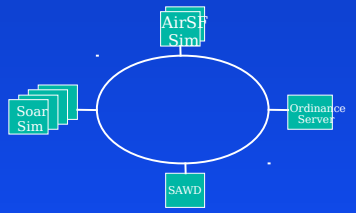
SAWD Demo Technical Approach

- Break the mold
  - The known restrictions (high cost and poor higher level behaviors) of present CGF's are not really intrinsic to CGF.
  - A new approach to CGF technology can provide command level behaviors and also interface to the existing CGF installed base .
- Prove concept of a new enabling technology: COREBA
  - COREBA means Cognition ORiented Emergent Behavior Architecture.
  - COREBA facilitates construction of human-like behaviors through its unique hybrid paradigm.
  - COREBA requires significantly less development efforts.
- Construct Synthetic AWACS Weapons Director (SAWD) demo
  - SAWD controls/coordinates many Air Synthetic Forces (AirSF) agents.
  - SAWD communicates with AirSF by exchanging radio messages.



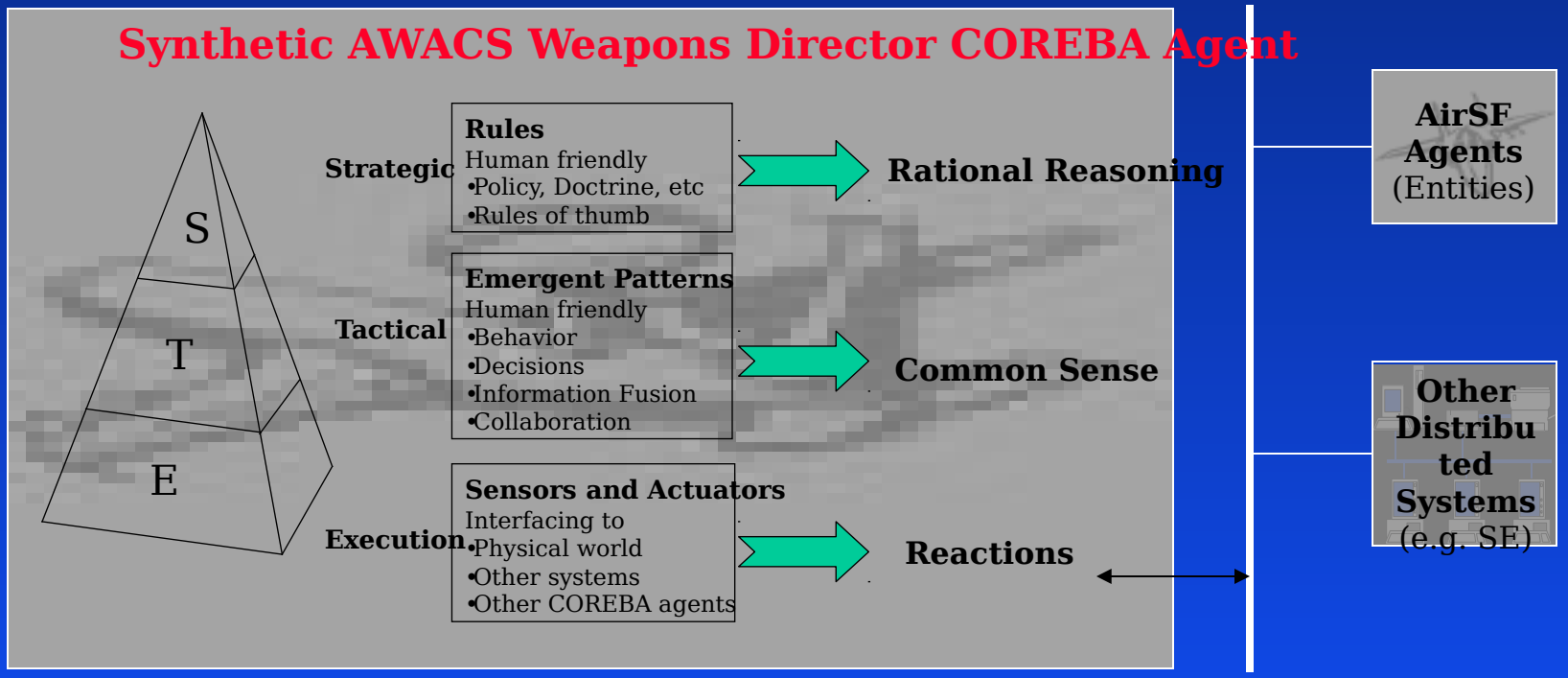


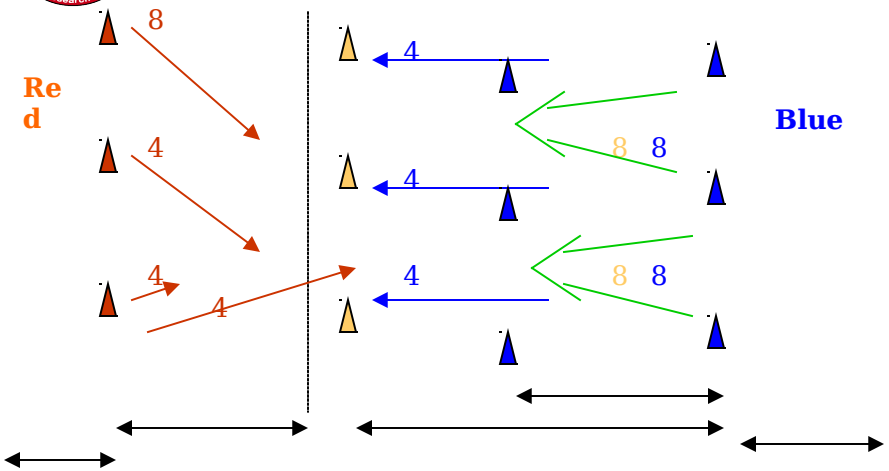
COREBA Agent

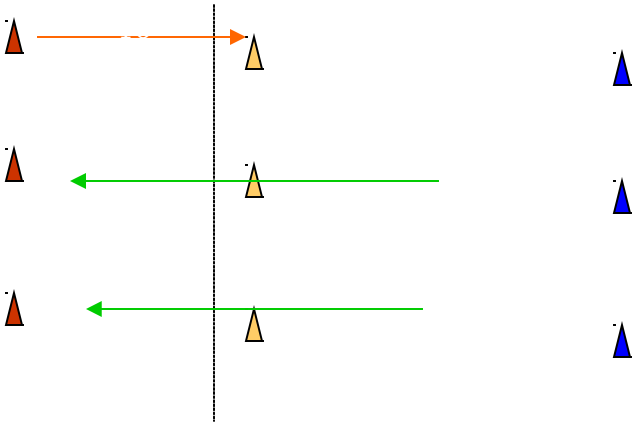


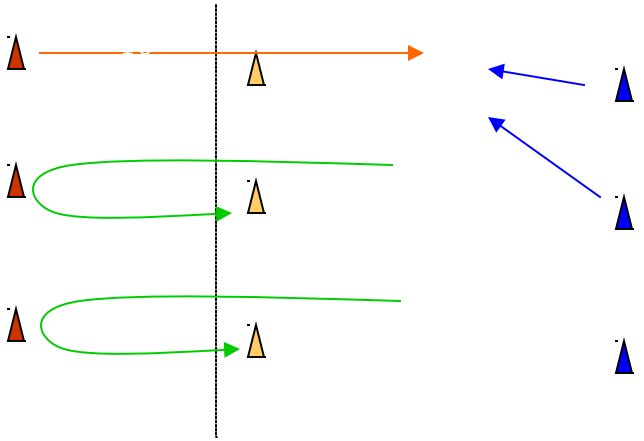
SAWD Demo

SAWD Demo Configuration

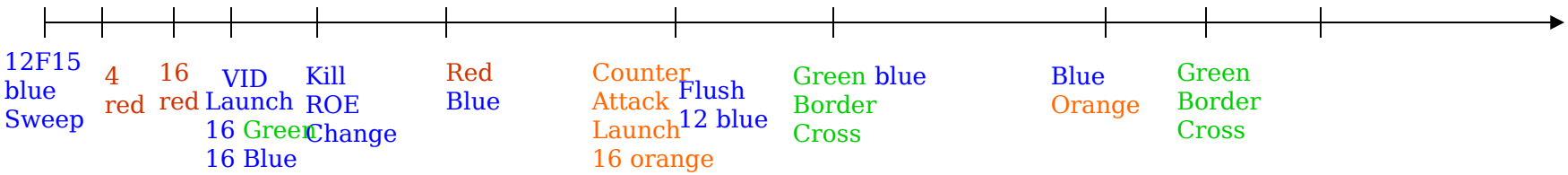






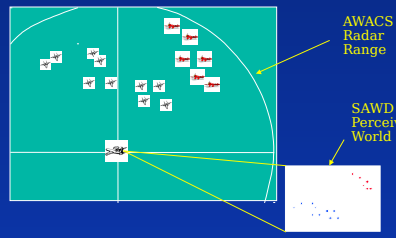


Type of simulation	Number of Planes (93)	Element Config.	Type of Planes	Home base	Call sign (initial char)
COREBA (1)	1		AWACS		
Soar (40)	12 16 12	6 x 2 ships 8 x 2 ships 6 x 2 ships	F-15C F-15E F-15C	1,2,3 B,C A,B	C E S
AirSAF (16)	16	8 x 2 ships	F-16C	B,C	B
AirSAF (36)	4 16 16	2 x 2 ships 8 x 2 ships 8 x 2 ships		Z X,Y,Z X	



What You Saw in the Demo

- SAWD makes many AirSF agents collaborate by
  - Anticipating the battle scenes (both BLUE and OPFOR)
  - Paring and Guiding the AirSF agents
  - Monitoring the engagement progress.
- SAWD automates AWACS weapons director operations.
  - Is fully adaptive to new situation
    - Does not require scripted scenario
    - Facilitates real time C4ISR injection
  - Reduces man power requirement for AWACS operation in support of pilot training
- SAWD was developed in two staff month effort.
  - The openness of COREBA facilitates integration with existing AirSF.
  - COREBA technology significantly reduces development cost and time.

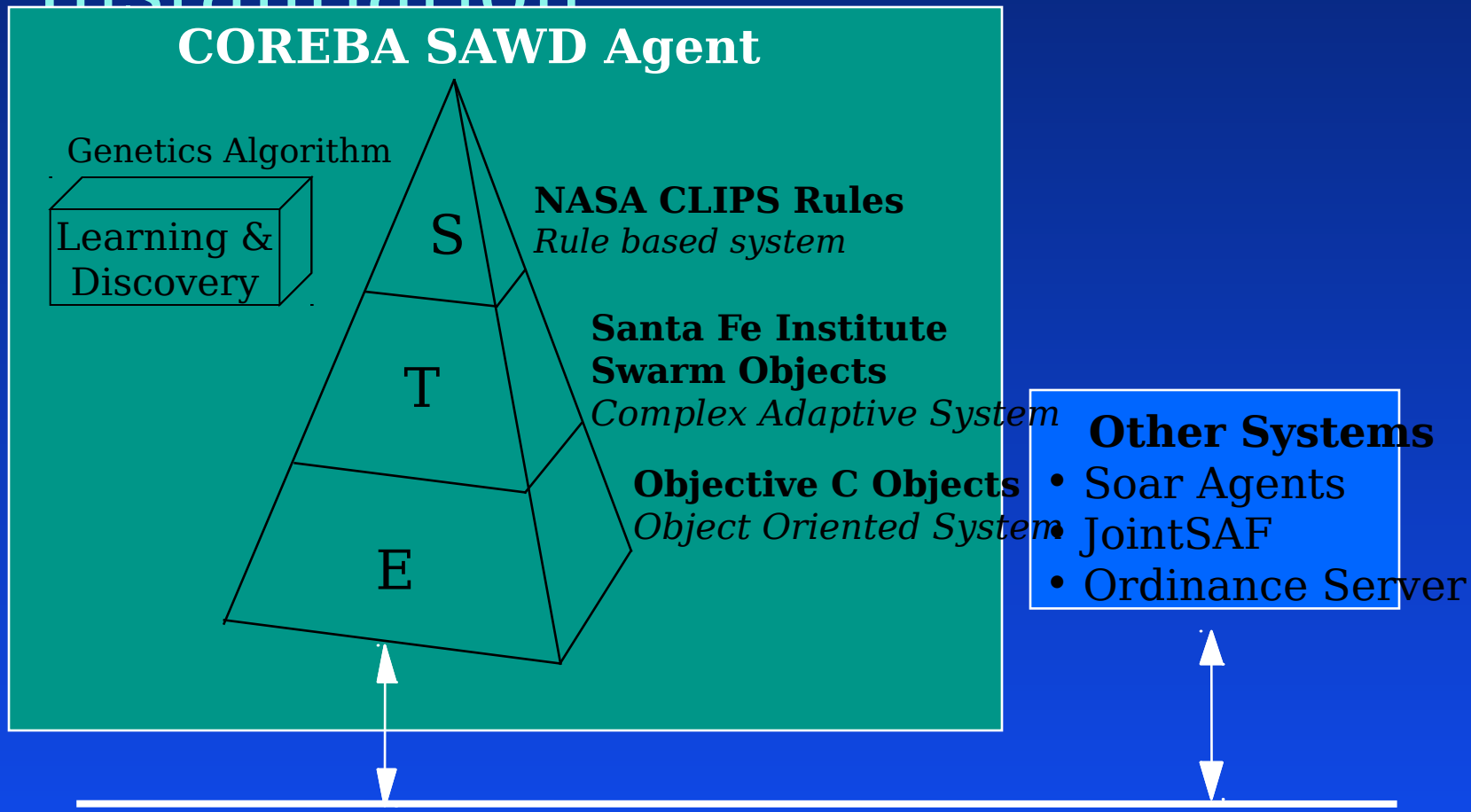


Automated AWACS Operat

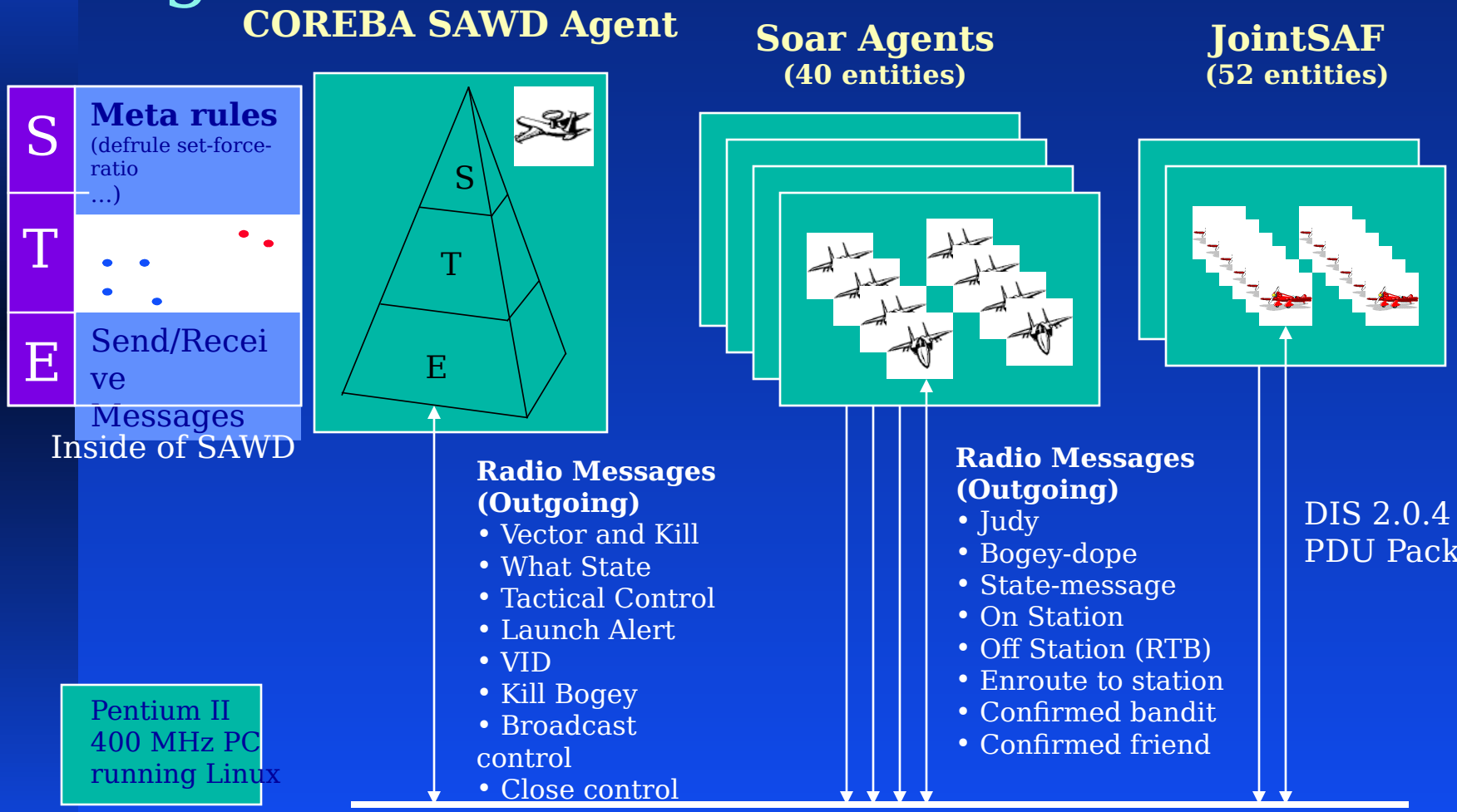
COREBA Open Architectur

Two Staff Month Effort

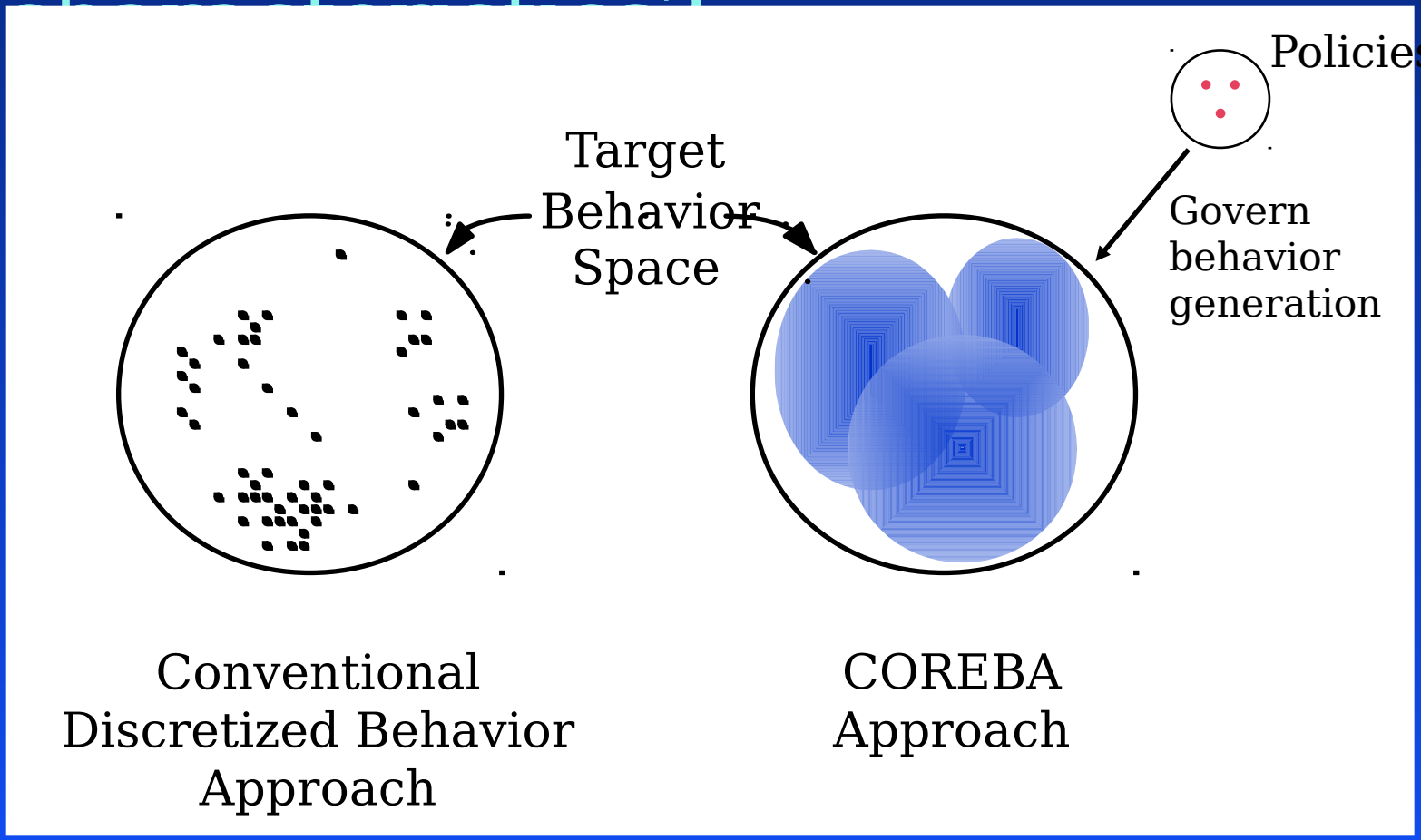
COREBA SAWD Agent Instantiation



How does SAWD guide Soar Agents?



Why does COREBA exhibit human-like behavior characteristics?



COREBA vs Other Approaches

COREBA

Guidelines — CLIPS Rules

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Common Sense — SWARM objects

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Desired Behaviors

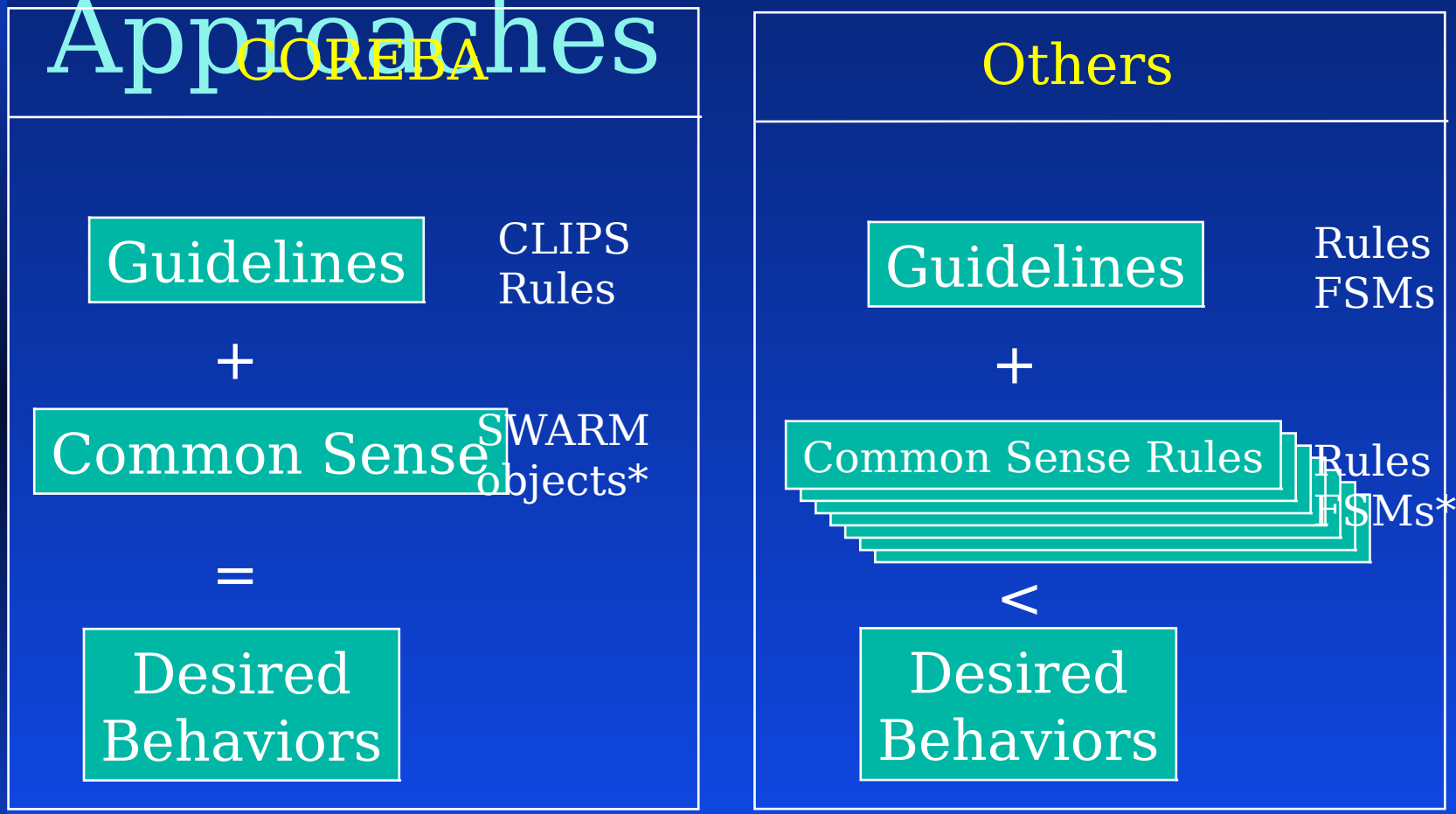
Others

Guidelines — Rules FSMs

?

Desired Behaviors

COREBA vs Other Approaches



Naturally creates human-like behaviors.

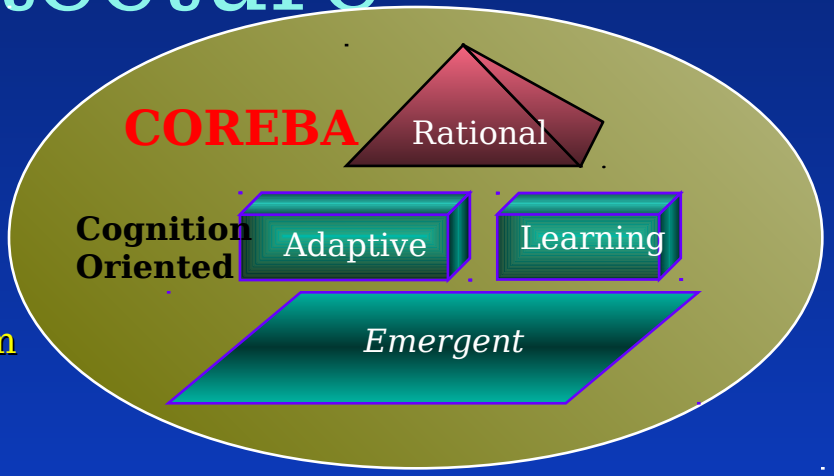
Only works if implemented.
Requires large numbers of rules/FSMs

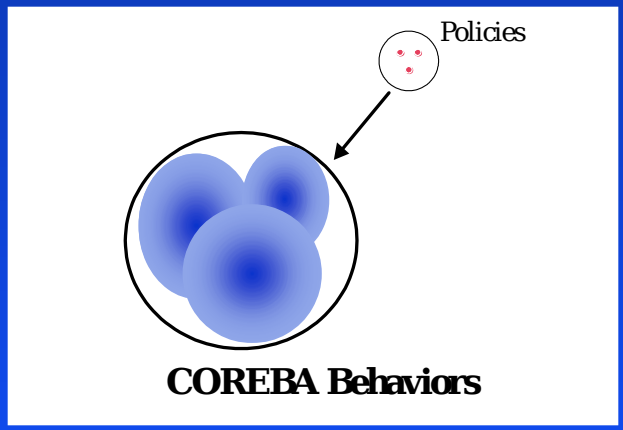
*: Implement behavior process

**: Implement behavior enumera

Therefore, COREBA Architecture

- Is a Multiple Paradigm Behavior Architecture
  - Rule based paradigm
  - Complex adaptive paradigm
  - Object oriented paradigm
  - Evolutionary computing paradigm
- Facilitates implementation of
  - Policy driven behaviors
  - Cognitive behaviors
  - Adaptive behaviors
  - Human-like **automated** behaviors
    - **Man power reduction**
- Is an Open/Nested Architecture
  - **Promotes reuse**
  - **Reduces development cost**





More Information about COREBA

- Handouts
  - General introduction to COREBA
  - Short description about SAWD (handed out by AFRL during Coyote98, Nov-98)
- White paper
  - Introductory paper, “Introduction to COREBA”
- Published papers
  - Kwak, S.D., "Cognition Oriented Behavioral Architecture (COREBA)", *Proceedings of the 7th Conference on Computer Generated Forces and Behavioral Representation*, IST, University of Central Florida, Orlando, FL, May, 12-14, 1998.
  - Kwak, S.D., "A Multiple Paradigm Behavior Architecture: COREBA (Cognition Oriented Emergent Behavior Architecture)", *Proceedings of 1998 Fall Simulation Interoperability Workshop*, SISO, Orlando, FL, Sept. 14-18, 1998.
  - Kwak, S.D., “Application of Nonlinear Dynamic Behavior Paradigm to the JFACC Force Selection Problem”, To appear in *Proceedings of the 8th Conference* on *Computer Generated Forces and Behavioral Representation,* IST, University of Central Florida, Orlando, FL, May, 11-13, 1999.
- Demos
  - JFACC demo (JFACC planning aid tool demo)
  - SAWD demo (Synthetic AWACS Weapons Director demo)
  - Tank company bridge crossing/engagement demo (Intelligent company commander)
  - Continuous planning, assessment, and execution demo for Air Domain (JFACC-SAWD-ModSAF Collaboration demo)
- POC
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